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COMBUSTION PROBLEMS IN  
ORR AND SEMBOWER INCORPORATED  
800 lbs/hr AUXILIARY BOILER  
(MSO CLASS)

A Research and Development Report

NBTL Project B-471  
Final Report

8 February 1963

by

J. J. HARDISH

**NAVAL BOILER AND TURBINE LABORATORY**  
**PHILADELPHIA NAVAL SHIPYARD**  
**PHILADELPHIA 12, PENNA.**

PLATE NO 10917



COMBUSTION PROBLEMS IN  
ORR AND SEMBOWER INCORPORATED  
800 lbs/hr AUXILIARY BOILER  
(MSO CLASS)

A Research and Development Report  
BUSHIPS Project No. S-FO13-08-12  
BUSHIPS Task No. 4172

NBTL Project B-471  
Final Report

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J. J. HARDISH

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COMBUSTION PROBLEMS IN  
ORR AND SEMBOWER INCORPORATED  
800 lbs/hr AUXILIARY BOILER  
(MSO CLASS)

Ref: (a) BUSHIPS ltr FO13-08-12 Ser 651A-980 of 14 July 1960  
(b) NBTL ltr Code 720, 9510(B-345) of 21 April 1960  
(c) Orr and Sembower Drawing 999301116 and 999301115, Burner  
assembly and details for size 2 Auxiliary Boiler  
(d) NBTL ltr Code 2720, 9510(B-471) of 20 October 1961

Encl: (1) NBTL SK. #A588 of final burner-air nozzle modification

BACKGROUND

1. During evaluation of the subject boiler, combustion performance was found to be poor. Reports from MSO ships having similar ferrous units were unanimous in indicating poor combustion and also pulsating performance during light-off and warm-up of the boilers. As a result, the Laboratory was authorized by reference (a) to investigate and remedy combustion difficulties in the subject boiler. A description of the boiler and results of its initial evaluation are presented in reference (b).

PROCEDURE AND RESULTS

2. Initially, under this investigation the existing burner on the Laboratory's boiler was modified in accordance with reference (c) to correspond to that furnished on the MSO-522 Class units. Operating trials totalling 85 steaming hours with this arrangement were still characterized by pulsations. As described in reference (d) indications were that the blower was improperly sized and was operating in an unstable area. As a result, a new blower assembly including a one-inch wheel and an intake air control damper was furnished by the manufacturer and installed on the Laboratory boiler.

3. Operating trials with the new blower system revealed no improvement in combustion performance. Violent pulsations were encountered frequently particularly during initial light-off. As a result, various burner modifications were made and evaluated using both the original and the new blower assemblies. Satisfactory results were finally obtained after several modifications were made to the burner air nozzle arrangement.

- a. All four of the 1/2 inch holes in the first inlet row of the burner air nozzle were plugged.
- b. 3-1/2 of the seven 5/8 inch holes in the second inlet row of the burner air nozzle were plugged.

- c. The outside diameter of the burner air nozzle exit end was reduced 0.010 inches to 3.430 inches.
- d. The burner oil tube was lengthened 3/16 of an inch so that distance between sprayer plate and end of nozzle is 11/16 of an inch.
- e. Ignition electrodes were reset.

4. With this burner arrangement, and the original blower system (2-3/16" blower wheel) satisfactory operation and light-off were obtained throughout the burner operating range during a period totalling 50 steaming hours. Inspection of firesides and burner assembly after completion of operation revealed no carbon deposits.

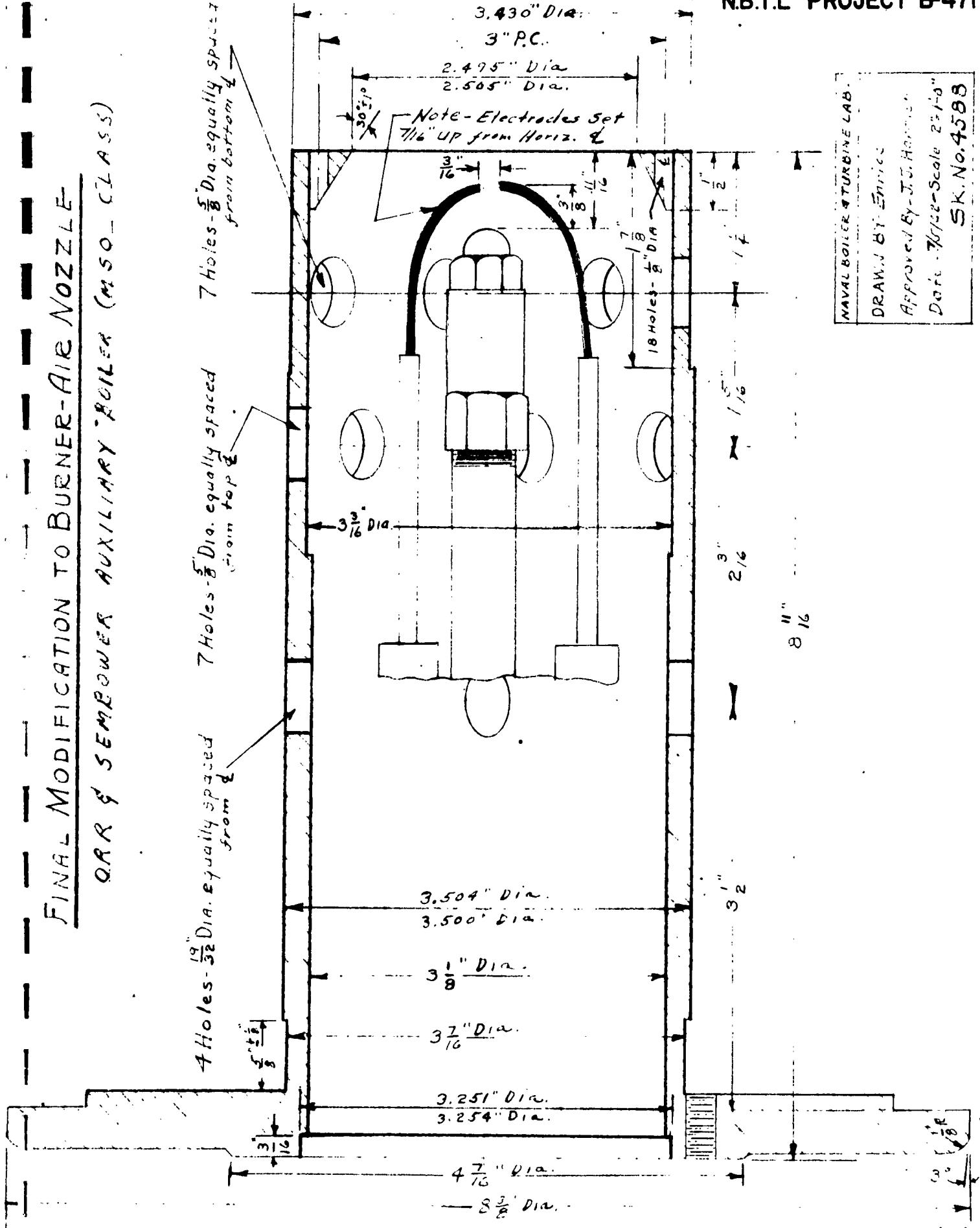
5. Boiler operation with the final burner modification was conducted over the firing range from 87 to 125 psig oil pressure with corresponding oil rates of 48 to 60 lbs per hour. (Full power or rated condition corresponds to 125 psig, oil pressure, and 60 lbs per hour, oil rate.) Gas analyses indicated CO<sub>2</sub> percentages ranged from 11 to 13.5 percent with a static (or blower discharge) pressure of 5.4 inches of water.

SUMMARY AND RECOMMENDATIONS

- 6. Combustion difficulties in the subject boiler were eliminated after a series of burner modifications. Violent pulsations were eliminated, combustion performance was improved, and positive and reliable ignition was obtained at all times. The original 2-3/16" blower wheel proved satisfactory after the burner modifications were made.
- 7. It is recommended that burner modifications be made on each boiler of the subject type now in service so that all units will agree with enclosure (1). The burner as shown in enclosure (1) differs from that shown in reference (c) as follows:
  - a. The first inlet row of 1/2 inch holes in the burner air nozzle has been eliminated.
  - b. The original second inlet row becomes the first row and is made up of four 19/32 inch diameter holes instead of seven 5/8 inch holes.
  - c. The outside diameter of the burner air nozzle exit end is reduced 0.010 inches to 3.430 inches.
  - d. The burner oil tube is 3/16 of an inch longer making the distance between sprayer plate and end of nozzle 11/16 of an inch.
  - e. Ignition electrodes were set 7/16 of an inch from horizontal center line of burner tip edge.

In addition, drawings should be changed as well as technical manuals to assure proper burner arrangement and, therefore, improve combustion performance in the future.

FINAL MODIFICATION TO BURNER-AIR NOZZLE  
ORR & SEMBOWSKI AUXILIARY NOZZLE (MSO-CLASS)



**ENCLOSURE (1)**